Semi-Annual Status Report

Grant NGR 03-002-122

"Astrometric and Astrophysical Investigations of Comets, Minor Planets, and Satellites"

1 February to 31 July 1967

Elizabeth Roemer
Principal Investigator

Lunar and Planetary Laboratory
University of Arizona
Tucson, Arizona 85721

OBSERVATIONS

During the report period, observing time has been scheduled with the 61-inch reflecting telescope of the Catalina Station of the Lunar and Planetary Laboratory on two nights per month to obtain photographic observations of comets, minor planets, and satellites. Some 91 plates were obtained on ten of the thirteen nights scheduled, as follows:

Comets	38 plates	Of, or in search for, 9 different comets.
Minor Planets	14 plates	Four minor planets, including (1566) Icarus and (1685) Toro, which cross inside the orbit of the earth.
Satellites	30 plates	Five faint outer satellites of Jupiter, two satellites of Mars, and Nereid, the irregular satellite of Neptune.
Selected Areas, and other fields	9 plates	For magnitude calibration, finding charts for photometry, etc.

Some plates have been measured for accurate positions, the fundamental data for determination and improvement of orbits. Because of the limited field of view of the 61-inch telescope at f/13.5, few reference stars, even from the Astrographic Catalogue, appear on each plate, and there is sometimes difficulty in finding a suitable reference frame for position determinations. The difficulty can be remedied by taking field plates with a wider-field instrument and using catalogue stars to determine the position of secondary reference stars. The secondary reference stars can then be used to define the coordinate frame on the 61-inch plates. The 7-inch Bailey astrograph of the

Steward Observatory, and, probably, the 16-inch Schmidt being constructed under this grant will be useful in obtaining the necessary field plates. The use of secondary reference stars, which can be selected with greater flexibility as to position and brightness, should yield positions of superior accuracy.

A graduate student in astronomy and NASA trainee, Lyn Doose, has programmed, as part of a summer study project, portions of the plate reduction calculations for digital computer. His programs will be useful in carrying out astrometric reductions, using either Astrographic Catalogue or secondary reference stars..

The plates taken for astrometric purposes are also suitable for estimation of the brightness of the solar system objects photographed, since in all cases appropriate motion is set off as the plates are exposed. In the case of comets, because of the open scale of the 61-inch, the brightness estimates refer essentially to the nucleus alone, rather than to the sum of the contribution from the nucleus and an additional (and unknown) contribution from the inner coma. Thus these brightness estimates are especially useful in deriving nuclear dimensions, as described below.

NUCLEAR RADII OF COMETS

Following the techniques used previously by L. Houziaux (Bull. Acad. Belg. 45, 218, 1959), the preliminary results on dimensions of cometary nuclei reported by E. Roemer (Mém. Soc. Roy. Sci. de Liège, 5th Series, Vol. XII, 23-28, 1966) have been extended to include practically all comets observed with the 40-inch Ritchey-Chrétien reflector of the U. S. Naval Observatory Flagstaff Station from 1957 through 1965. The magnitude data consist of eye-estimates from plates taken for astrometric purposes and is very similar to that now being derived from observations with the Catalina reflector.

In deriving nuclear dimensions from photometric measures the cometary nucleus is assumed to be monolithic and to reflect light according to Lambert's law. Limiting dimensions have been obtained by assuming two values of the albedo, 0.02, and 0.7, representing extreme values observed in the solar system. The true albedos almost certainly lie between, and may vary considerably from comet to comet. Figures 1 and 2 show the frequency distribution functions of sizes derived for periodic comets and for comets moving in nearly parabolic orbits. It is to be noted that periodic comets show a much greater frequency of small sizes, a fact consistent with the generally accepted idea that the short-period comets are captured from those moving in very elongated orbits, especially through the effect of perturbations by Jupiter. They would thus have moved in the inner solar system, where they suffer loss of material through exposure to fairly intense solar radiation, for an appreciably longer time.

Analysis of correlations of dimensions with various orbital and physical parameters is in progress. It is intended to present a brief report at the Prague General Assembly of the I. A. U. and to submit a more detailed report shortly for publication. The calculations of nuclear dimensions also will be extended to photometric data derived with other long focus telescopes, especially the 36-inch f/5.8 Crossley reflector of the Lick Observatory and the 82-inch f/4 reflecting telescope of the McDonald Observatory.

SCHMIDT TELESCOPE

Optical work on the primary mirror of the proposed 16-inch f/3 Schmidt telescope has been completed in the Laboratory's optical shop. The correcting plate requires only final figuring, which will be carried out after mechanical assembly of the camera.

Mechanical design, in progress, is being aided by copies of assembly drawings of the Palomar 18-inch f/2.5 Schmidt camera, kindly made available

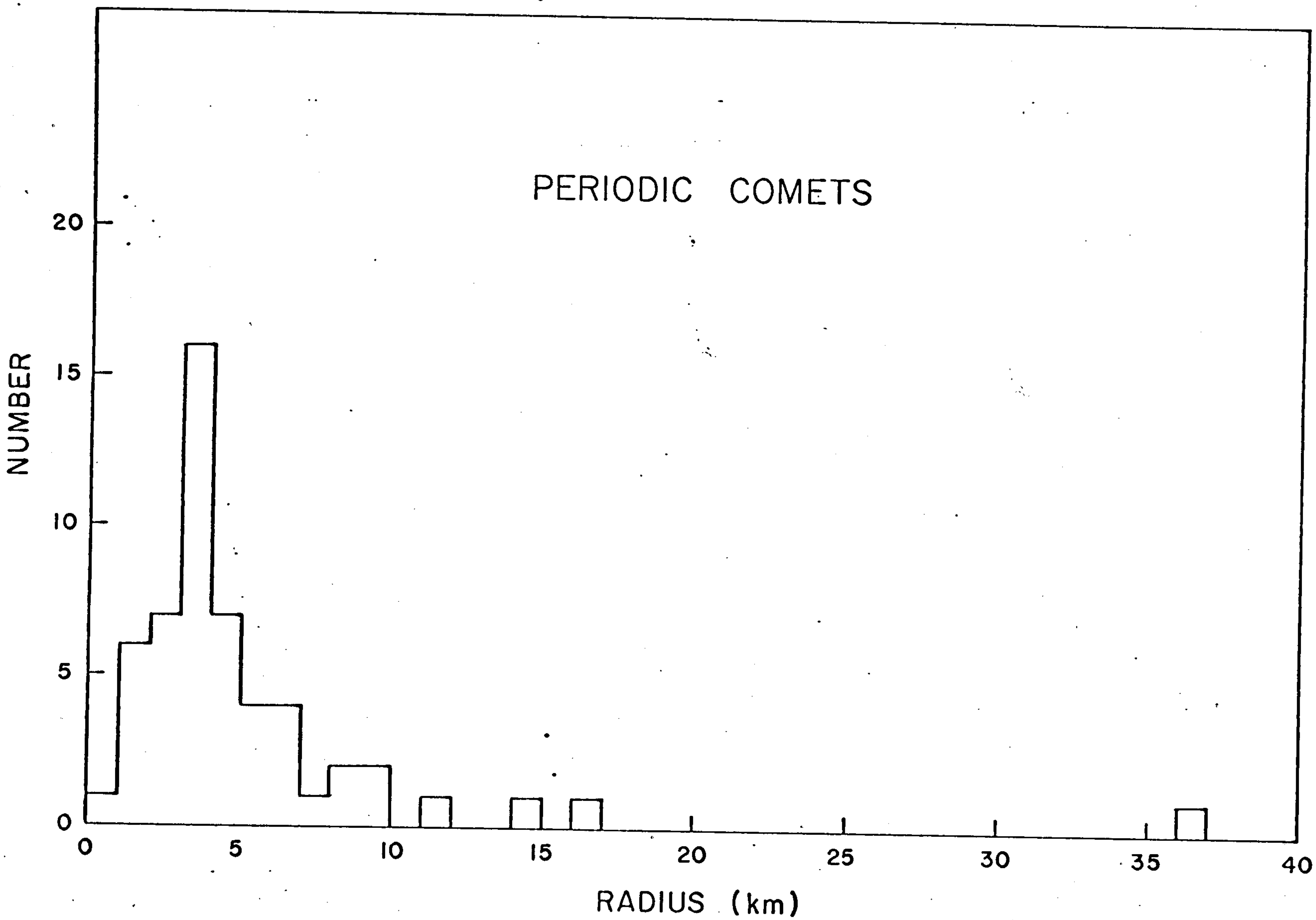

Fig. 1 Frequency distribution of nuclear radii of short-period comets. The radii have been calculated with an assumed albedo of 0.02. If the albedo were as high as 0.7, the radii would be reduced to 1/6 the plotted values.

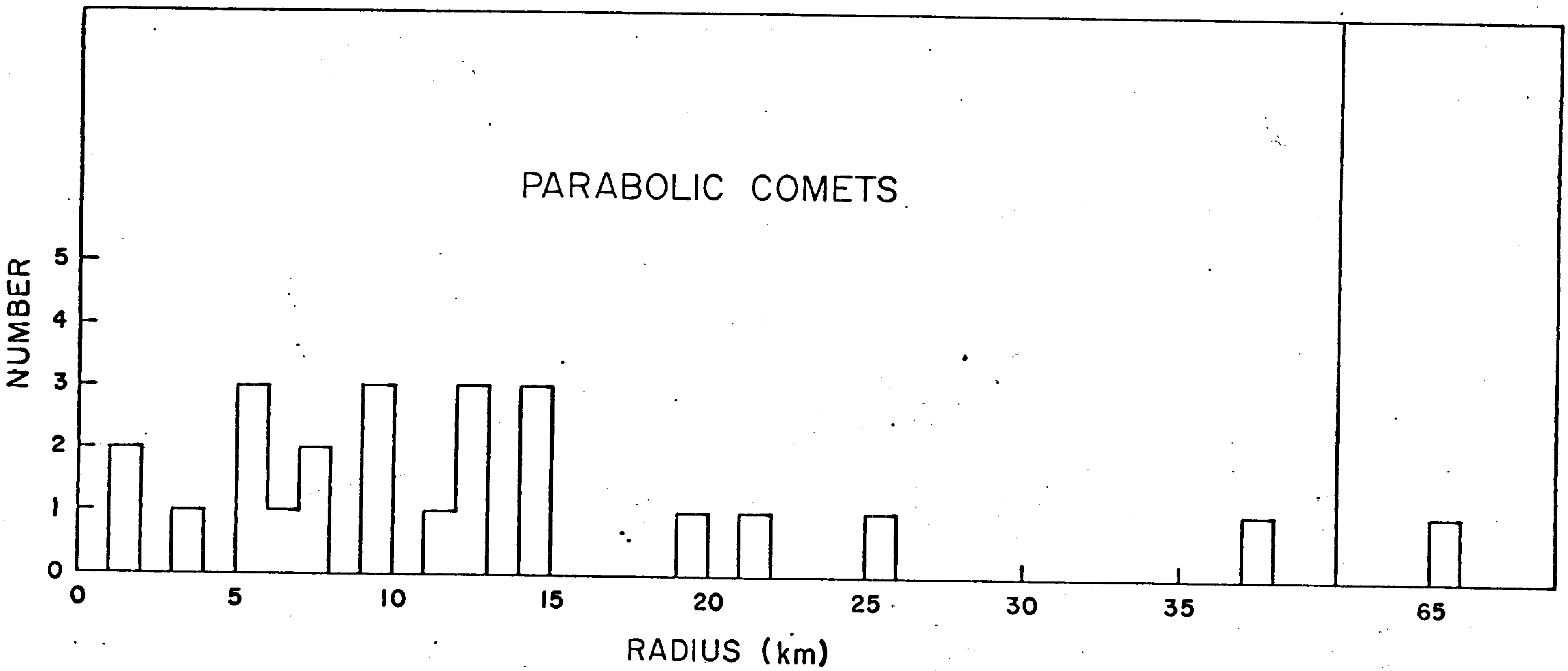

Fig. 2 Frequency distribution of nuclear radii of comets moving in nearly parabolic orbits. The radii, as in Fig. 1, have been calculated with an assumed albedo of 0.02. If the albedo were as high as 0.7, the radii would be reduced to 1/6 the plotted values.

by Mr. Bruce Rule of the Mount Wilson and Palomar Observatories. Arrangements have also been made to confer at the Prague meeting of the I.A.U. with astronomers of the University Observatory, Bern, Switzerland, who have agreed to furnish information regarding their 16-inch Schmidt.

The camera, when it is completed about January 1968, will be installed in the existing 20 ft dome on the mounting now used for the 21-inch photometric telescope, located at this Laboratory's Catalina Station.

COMET HEAD AND TAIL STRUCTURES

Advantage was taken of the attendance of Dr. G. Van Biesbroeck, for many years a member of the staff of the Yerkes Observatory, at the June meeting of the American Astronomical Society at Yerkes to secure his guidance in examining photographs of comets in the Yerkes collection, many of which he took. The Yerkes (and McDonald) collection, together with the Naval Observatory collection now under study under this Grant, constitute a very large fraction of the existing long-focus material for study of cometary structural features, especially in the vicinity of the nucleus. It is hoped eventually to be able to ascertain the place and mode of formation of tail rays, and to recognize structural features that may be associated with ionization mechanisms. The convergence of tail rays on smaller-scale plates has seemed to place the origin of the tail ray system close to, or perhaps on the sunward side of, the nucleus. Some of the long-focus plates definitely show rays appearing, usually in symmetrical pairs, in regions of considerable lateral displacement from the radius vector from the sun. It seems likely that the rays appear at a rather sharply defined interface that represents some phase of the interaction between the cometary plasma and the charged particle stream of the solar wind.

The long-focus plate material represents also an important portion of that to be included in an atlas of representative structural forms of comets. The atlas project is being organized with the collaboration of Drs. Bertram Donn and Jurgen Rahe, NASA-Goddard Space Flight Center, who also attended the Yerkes meeting and shared in the examination of the Yerkes collection of comet plates. Rahe has been working recently at Goddard with Dr. K. Wurm, of the Hamburg Observatory, on certain aspects of head structure, and the opportunity during the Yerkes meetings to discuss recent findings with him and with Donn and to consider cooperative future work was extremely valuable. Rahe probably will spend several weeks in Tucson in the fall to collaborate on studies of cometary structural features.